



July 9<sup>nd</sup>, 2012

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## **GILDRED SOLAR #1 SENSITIVITY STUDY**

Imperial Irrigation District  
Sensitivity Study

## TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>3</b>
<b>STUDY OVERVIEW .....</b>	<b>7</b>
<b>STUDY METHODOLOGY AND EVALUATED CRITERIA .....</b>	<b>8</b>
POWER FLOW ANALYSIS.....	8
TRANSIENT STABILITY ANALYSIS .....	9
<b>STUDY BASE CASE DESCRIPTION AND ASSUMPTIONS.....</b>	<b>13</b>
BASE CASE ASSUMPTIONS .....	13
BASE CASES STUDIED .....	13
GS1 PROJECT SHORT CIRCUIT MODEL ASSUMPTIONS .....	14
<b>STUDY RESULTS.....</b>	<b>15</b>
POWER FLOW ANALYSIS FINDINGS .....	15
Heavy Summer Pre and Post Project Base Case.....	15
Light Winter Pre and Post-Project Base Case.....	16
SHORT CIRCUIT ANALYSIS FINDINGS .....	17
<b>MITIGATION PLANS.....</b>	<b>18</b>

## LIST OF APPENDICES

Appendix A1 – Power Flow Maps  
Appendix A2 – Summary of Power Flow Analysis Results  
Appendix A3 – Short Circuit Results

## LIST OF ATTACHMENTS

Attachment A –Transient Stability Plots

## **EXECUTIVE SUMMARY**

The Imperial Irrigation District System Planning group was requested to perform a sensitivity analysis for the Gildred Building Company. The study was conducted to determine the impacts of the proposed Gildred Solar #1 (GS1) Project. This section provides a summary of the study results for integrating the GS1 project into the Imperial Irrigation District (IID) transmission system. Detailed study results can be found in the subsequent sections of this report.

### **Disclaimer**

This study was performed at the request of Gildred Building Company to accommodate its requirements for permitting of the project in San Diego County. While this analysis identifies potentially impacted transmission elements, it is not comprehensive and is not intended to address all impacts on the IID system and proposed mitigations. This study report will not be used as a method to accelerate the Gildred Building Company interconnection request over higher queued projects for purposes of a Generator Interconnection Agreement.

This report does not constitute an offer of transmission service nor confer upon the Interconnection Customer, any right to receive transmission service from IID. IID and its neighboring interconnected utilities may not have the Available Transmission Capacity to deliver to any customer or Point of Delivery.

It must also be noted that the study results for the analysis presented in this report are highly dependent upon the data provided by the interconnection customers such as machine models, points of interconnection and timing of proposed projects. Any modification to the data provided in the interconnection application invalidates the results of this study.

During this study, neighboring utility systems were not monitored, and at this point the impacts are unknown due to the proposed generation project.

### **Overview**

The Imperial Irrigation District (IID) is currently performing a Cluster System Impact Study #1. The proposed project evaluated in this report is the GS1 project, which is one of the participants in the cluster study #1. IID was requested by the Gildred Building Company to perform a sensitivity analysis on the GS1 project outside of the cluster study #1. On the radial line where the GS1 project is planning to interconnect there is also another planned generation interconnection project. Due to the radial characteristic of the line and the similar electrical points of the two generation projects, IID has decided to review the sensitivity analysis of the GS1 project with and without the added generation. The study was conducted using a Western Electricity Coordination Council's (WECC) approved heavy summer and light winter power flow base case with a detailed IID system representation incorporated. Studies performed included power flow, and short circuit analyses.

### Project Description

The study performed contains one active interconnection request. Provided below are higher level descriptions of the proposed project:

- Gildred Solar #1: A 50 MW solar photovoltaic project with a planned interconnection on the IID 92 kV "R" line by 2012. The project is planned to be delivered to SDG&E.

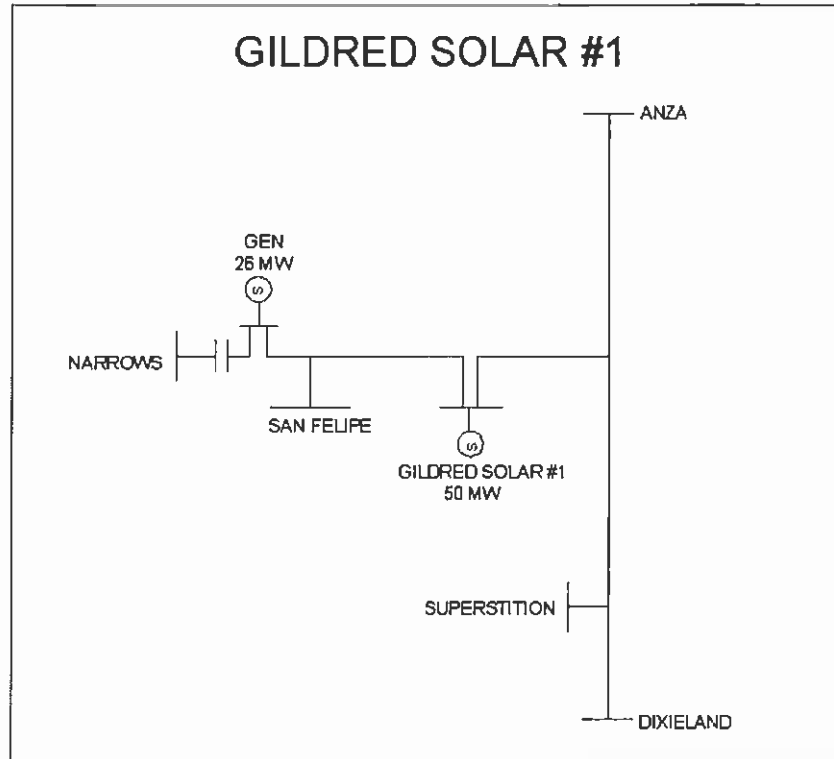


Figure 1: Gildred Solar #1 Project with added generation

### Study Approach

In conducting the Study, the proposed project was studied according to the project in-service date. For projects with different phases of implementation, the entire project output was considered operational in the year in which the first phase commences operation. Table I depicts the projects and the WECC base model used for studying the project.

Projects	WECC Base Model
GS1 Solar 50 MW	2012 heavy summer and 2012-2013 light winter models
GS1 Solar 50 MW Generation 26 MW	2012 heavy summer and 2012-2013 light winter models

TABLE I: WECC Base Case selection for GS1 20 MW Interconnection

The output from the generation project was dispatched and delivered to SDG&E. Power flow and short circuit analyses were conducted. The adequacy of the study results were evaluated using WECC/NERC reliability and the IID planning standards. Impacts of the generation project to the IID system were determined and mitigation plans may be recommended. The mitigation plans are designed to ensure cost is contained and development is coordinated with IID future transmission plan objectives.

### **IID Transmission System Impacts**

The studies described in this report showed that the interconnection of the proposed generation project triggered new transmission overloads under single and credible double element outage conditions. The detail impact of the project can be found in the “Study Results” section of this report.

The addition of the proposed projects adversely impacted the voltage performance of the IID transmission system resulting in additional violation, also the project would be expected to ensure at a minimum of zero reactive power exchange between its project and the IID transmission system at the point of interconnection. The study identified the reactive power resources that are needed to maintain acceptable voltage performance on the IID transmission system.

The short circuit analysis showed that the interconnection of the proposed project would not cause IID breakers to exceed their interrupting capabilities.

### **Recommended Mitigation Plan, Cost and Construction Timelines**

To mitigate the identified impacts to IID transmission system following the addition of the project, IID developed an iterative process that ensured that any mitigation plan designed meets the following objectives:

- It ensures that WECC/NERC reliability standards are met
- It fits into IID long term transmission expansion plans
- It is cost effective.

Based on the power flow and short circuit studies, mitigation plans will be necessary for the GS1 Solar project. The power flow results for both the heavy summer and light winter base cases can be found in Appendix A2. Power flow maps with all transmission lines in service can be found in Appendix A1.

### **High Level Cost Estimate**

#### **Considering 50MW & 26 MW in service:**

The following is a high level cost estimate for implementing the recommended two SOPs:

\$ 400,000 (2012 US Dollar)

The following is a high level cost estimate for implementing the recommended two SPSs:

\$ 700,000 (2012 US Dollar)

Mitigation costs for upgrading IID impacted equipment:

\$ 27,736,540 (2012 US Dollar)

**Total HLCE Allocated to the CSE Project :**

**\$ 28,465,369 (2012 US Dollar)**

#### **Considering only 50MW in service:**

The following is a high level cost estimate for implementing the recommended two SOPs:

\$ 400,000 (2012 US Dollar)

The following is a high level cost estimate for implementing the recommended three SPSs:

\$ 1,050,000 (2012 US Dollar)

Mitigation costs for upgrading IID impacted equipment:

\$ 6,583,389 (2012 US Dollar)

**Total HLCE Allocated to the CSE Project :**

**\$ 7,833,389 (2012 US Dollar)**

## STUDY OVERVIEW

The Imperial Irrigation District (IID) is currently performing a Cluster System Impact Study #1. The proposed project evaluated in this report is the GS1 project, which is one of the participants in the cluster study #1. IID was requested by the Gildred Building Company to perform a sensitivity analysis on the GS1 project outside of the cluster study #1. On the radial line where the GS1 project is planning to interconnect there is also another planned generation interconnection project. Due to the radial characteristic of the line and the similar electrical points of the two generation projects, IID has decided to review the sensitivity analysis of the GS1 project with and without the added generation. The study was conducted using a Western Electricity Coordination Council's (WECC) approved heavy summer and light winter power flow base case with a detailed IID system representation incorporated. Studies performed included power flow, and short circuit analyses.

The study performed contains one active interconnection request. Provided below are higher level descriptions of the proposed project:

- Gildred Solar #1: A 50 MW solar photovoltaic project with a planned interconnection on the IID 92 kV "R" line by 2012. The project is planned to be delivered to SDG&E.

In conducting the study, the proposed project was studied according to the project in-service date. For projects with different phases of implementation, the entire project output was considered operational in the year in which the first phase commences operation. Table II depicts the projects and the WECC base models used for studying the project.

Projects	WECC Base Model
GS1 Solar 50 MW	2012 heavy summer and 2012-2013 light winter models
GS1 Solar 50 MW Generation 26 MW	2012 heavy summer and 2012-2013 light winter models

**TABLE II: WECC Base Case selection for GS1 20MW Interconnection**

The output from the generation project was dispatched and delivered to SDG&E. Power flow and short circuit analyses were conducted on the project. The adequacy of the study results were evaluated using WECC/NERC reliability and the IID planning standards. Impacts of the generation project to the IID system were determined and mitigation plans may be recommended. The mitigation plans are designed to ensure cost is contained and development is coordinated with IID future transmission plan objectives.

## STUDY METHODOLOGY AND EVALUATED CRITERIA

The analyses performed in this study included power flow, transient stability, post-transient stability and short circuit. This section provides a summary of the methods and the evaluation criteria used for analyzing the results of the studies.

### Power Flow Analysis

Power flow analysis was conducted on all the pre- and post-project base cases developed for the GS1 study. Power flow analysis considers a snapshot in time where tap changing transformers, Static VAR Devices (SVD) and phase-shifters have had time to adjust. In addition, a swing generator balances generation and load (plus losses) on the system during each contingency scenario. The power flow analysis was conducted with version 18 of General Electric's PSLF software. Power flow results were monitored and reported for the IID and the neighboring control areas.

Thermal and voltage performance of the system was evaluated under normal (N-0), single element outage (N-1) and select double element outage (N-2) conditions. Thermal loadings were reported when a modeled transmission component is loaded to 100% or more of its continuous MVA rating (as provided in the power flow database).

Transmission voltage violations for N-0 conditions were reported when per unit voltages were less than 0.95 or greater than 1.05. Transmission voltage violations following N-1 or N-2 outage were reported when per unit voltage was less than 0.90 or greater than 1.05. Additionally, voltage deviations between the pre- and post-contingency conditions were recorded whenever these deviations were greater than 5% for single contingencies and 10% for double contingencies.

In summary, the following WECC/NERC reliability criteria were used to assess the adequacy of the power flow study results:

- Pre-disturbance bus voltage must be between 0.95 per unit and 1.05 per unit. (an IID-specific requirement)
- Allowable voltage deviation of five (5) percent for N-1 Contingencies (deviation from pre-disturbance voltage).
- Allowable voltage deviation of ten (10) percent for N-2 contingencies (deviation from pre-disturbance voltage).
- Post-transient bus voltage must be at least 0.90 per unit (an IID-specific requirement)
- Pre- and post-disturbance loading to remain within the emergency ratings of all equipment and line conductors. The emergency ratings are determined by the owner/operator of each equipment item.

As applied in the analysis, all tables and results for loading criteria were based on the normal or continuous rating (Rating 1) for all lines in service conditions and the emergency rating (Rating 2) for outage conditions.



## Transient Stability Analysis

Transient stability analysis is a time-based simulation that assesses the performance of the power system shortly before, during, and after a contingency. Transient stability studies were performed on both the pre- and post-project base cases to verify the stability of the system following a system fault. Transient stability analysis was performed based on WECC Disturbance-Performance Criteria for selected system contingencies using version 18 of General Electric's PSLF software. Transient stability contingencies were simulated for 10 seconds, excluding one (1) second of pre-disturbance data. All simulated faults, unless specified, were assumed to be three-phase with a 4 cycle breaker clearing time. System damping was assessed visually with the aid of stability plots.

Selected critical contingencies were simulated. Provided below are the outages simulated.

- Imperial Valley-Miguel 500 kV line outage
- Palo Verde-Devers 500 kV line outage
- N. Gila-Imperial Valley 500 kV line outage
- Imperial Valley-El Centro 230 kV line outage
- Ramon-Mirage 230 kV line outage
- Coachella -Devers 500 kV line outage
- ELSTM2 and REPU2 generator outages

The following WECC transient voltage dip and transient frequency criteria were used to evaluate the impact of the project. A summary of the transient stability analysis evaluation criteria is provided in Table 2 and depicted graphically in Figure 1.

- WECC transient voltage dip criteria: The transient voltage dip must not exceed 25% at load buses or 30% at non-load buses for N-1 contingency. For N-2 contingency, the transient voltage dip must not exceed 30% at any bus. The maximum duration of the voltage dip of 20% at load buses must not exceed 20 cycles for N-1 contingency or 40 cycles for N-2 contingency.
- WECC transient frequency criteria: The minimum transient frequency for N-1 contingency is 59.6 Hz; if below 59.6 Hz, the duration must not exceed 6 cycles at load bus. For N-2 contingencies, the minimum transient frequency is 59.0 Hz; if below 59.0 Hz, the duration should not exceed 6 cycles at load bus.

The following parameters were plotted on the stability plots:

- **Bus Voltage**  
Bus voltage plots provide a means of detecting out-of-step conditions and are useful to assess the magnitude and duration of post disturbance voltage dips and peak-to-peak voltage oscillations. The voltage plots also indicate system damping response and the expected bus voltage following the disturbance.
- **Bus Frequency**  
Bus frequency plots provide expected magnitude and duration of post-disturbance frequency swings as well as indicating possible over-frequency or under-frequency conditions.

Six (6) critical buses which provide a representative illustration of the transmission system performance following each of the critical outages studied were monitored. The monitored buses included:

- Coachella 230 kV
- Ramon 230 kV
- El Centro 161 kV
- Niland 161 kV
- Mall 92 kV
- Avenue 42 92 kV

NERC and WECC Categories	Outage Frequency Associated with the Performance Category (outage/year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard	Post Transient Voltage Deviation Standard
A System normal	Not Applicable	Nothing in addition to NERC		
B One element out-of-service	$\geq 0.33$	Not to exceed 25% at load buses or 30% at non-load buses. Not to exceed 20% for more than 20 cycles at load buses.	Not below 59.6Hz for 6 cycles or more at a load bus.	Not to exceed 5% at any bus.
C Two or more elements out-of-service	0.033 – 0.33	Not to exceed 30% at any bus. Not to exceed 20% for more than 40 cycles at load buses.	Not below 59.0Hz for 6 cycles or more at a load bus.	Not to exceed 10% at any bus.
D Extreme multiple-element outages	$< 0.033$	Nothing in addition to NERC		

**Table 2: Stability and Post-transient Analysis Evaluation Criteria**

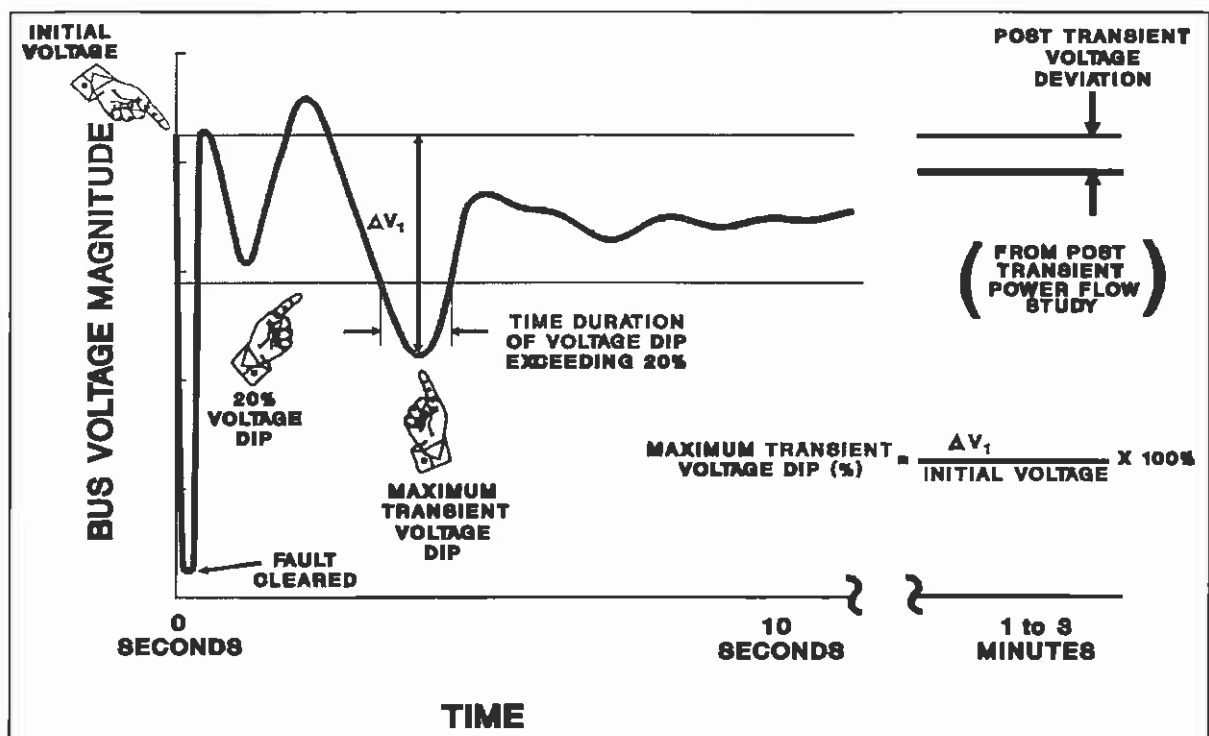


Figure 1: Graphical Representation of Stability Analysis Evaluation Criteria

#### *Post-Transient Stability Analysis*

Post-transient stability analysis was performed on selected buses in the IID transmission system following selected critical outages. Governor power flow tools were used for the analysis. For each bus assessed, a synchronous condenser was modeled to extract reactive power till voltage collapse occurs. The maximum reactive power consumed prior to the voltage collapse is determined.

The post-transient stability analysis related assumptions made are:

- Loads were modeled as constant MVA during the post-transient time frame
- Reactive power output of the system swing generator was limited to its maximum capability.
- No manual operator intervention was allowed to increase generator MVAR flow.
- Remedial actions such as generator dropping, load shedding or blocking of automatic generator control were not considered for single outages.

The list outages simulated and the buses monitored are provided below.

- Imperial Valley-Miguel 500 kV line outage
- Palo Verde-Devers 500 kV line outage
- N. Gila-Imperial Valley 500 kV line outage
- N. Laquinta-Avenue 42 92 kV line outage
- Imperial Valley-El Centro 230 kV line outage
- Ramon-Mirage 230 kV line outage
- Coachella-Devers 230 kV line outage
- ELSTM2 and REPU2 generator outages

The monitored buses included:

- AV58 161 kV
- Coachella Valley 161 kV
- N. Laquinta 92 kV
- Coachella Valley 92 kV
- Midway 92 kV
- Niland 92 kV
- El Centro 92 kV
- Calexico 92 kV
- Pilot Knob 92 kV
- Dixieland 92 kV

For post-transient stability, positive reactive margin must be achieved at all buses. For IID transmission system the post-transient stability analysis evaluated criteria used are:

- Minimum reactive power margin at any bus following N-1 outage is 100 MVAR
- Minimum reactive power margin at any bus following N-2 outage is 50 MVAR

#### ***Short Circuit Analysis***

Short circuit analysis was performed to determine the impact of the addition of the project on selected IID substation breaker duties. The analysis was performed using the ASPEN program and the machine data contained in the project's interconnection application.

Fault duties were calculated for both single-phase -to- ground and three-phase faults at the selected substation buses prior to and after the interconnection of the project. The incremental fault duties due to project were calculated. The fault contributions from the project were compared to the available margins of the vicinity breakers to determine if a breaker's interrupting capabilities is exceeded following the addition of the project.

## STUDY BASE CASE DESCRIPTION AND ASSUMPTIONS

### Base Case Assumptions

The GS1 study was performed using the following WECC approved power flow models as the starting base cases:

- Heavy summer . . . . 12hs4a.savv .....Approved WECC Case 01/11/2012
- Light winter . . . . . 12lw2a.sav.....Approved WECC Case 05/17/2011

Both power flow base cases were selected because they were the most recently developed and available base cases in the WECC library based on planned in-service date of the GS1 project. Pre-project base cases were developed from the starting base cases by incorporating IID detailed system representation. IID system loads, resources, and topology were adjusted to reflect the conditions expected in 2012 when the GS1 project plans to initiate operations. Queued generation projects with planned interconnection to IID transmission system prior to the interconnection were modeled in the pre-project base cases.

While it is impossible to study all IID transmission system flows and generation levels during all seasons, these two pre-project base cases represent extreme generation and transmission flows that will potentially expose any transmission constraints at the interconnection point.

### Base Cases Studied

Three (3) pre-project base cases were developed for the GS1 project study. The pre-project base cases were initially tested to ensure that all transmission facilities in IID control area are within their normal operating limits. The 3 pre-project base cases represent a benchmark for post-project evaluations. Three (3) post-project base cases were developed from the pre-project base cases by modeling the GS1 project in-service.

The six (6) base cases developed and used for studying the impact of the GS1 project are summarized in Table 3.

Season	PSLF Case Name	Description
2012 Heavy Summer		Planned IID heavy summer configuration without GS1 project and without 26 MW generation in service
2012 Heavy Summer		Planned IID heavy summer configuration with GS1 project and without 26 MW generation in service
2012 Heavy Summer		Planned IID heavy summer configuration with GS1 project and with 26 MW generation in service
2012 Light Winter		Planned IID light winter configuration without GS1 project and without 26 MW generation in service
2012 Light Winter		Planned IID light winter configuration with GS1 project and without 26 MW generation in service
2012 Light Winter		Planned IID light winter configuration with GS1 project and with 26 MW generation in service

**Table 3: Study Base Cases-GS1**

### **GS1 Project Short Circuit Model Assumptions**

IID supplied the ASPEN base case (Pre-Project) for the analysis. The model for the GS1 Project was developed for the Post-Project case based on the interconnection application for the development of the Project as a single 50 MW Photovoltaic (PV) and its related facilities. The details of the short circuit models for the GS1 Project are listed below:

#### Interconnect Facilities

##### **Step-Up Transformer:**

34.5/92 kV, Wye-Wye

50 MVA, 1 Transformer

X = 8.9%, X0 = 8.9% (55 MVA base)

**92V Transmission Line:** (100MVA base, 1.6 miles in length, 1- 266.8 kcmil/ phase)

*Note: Positive and Zero Sequence impedance assumed to be negligible for this analysis.*

**Equivalent Generator Data** (for limiting fault current to full (125%) PV output current of 1171.7A at 34.5kV):

Terminal Voltage: 34.5kV

Max PV Output Rating: 50MW

Max PV Output Current Rating: 1171.7A (at 34.5kV)

Subtransient Reactance (representation only) =  $X''_d = 0.800$  p.u.

*(Note: this represents a fault contribution of 10MW delivered to the Heber Solar Project 34.5kV bus and ignores project losses)*

The above models were added to the IID provided pre-project base case based on the assumptions provided by Gildred Solar #1 Project interconnection application; the model was developed in the

ASPEN One-Liner post-project case.

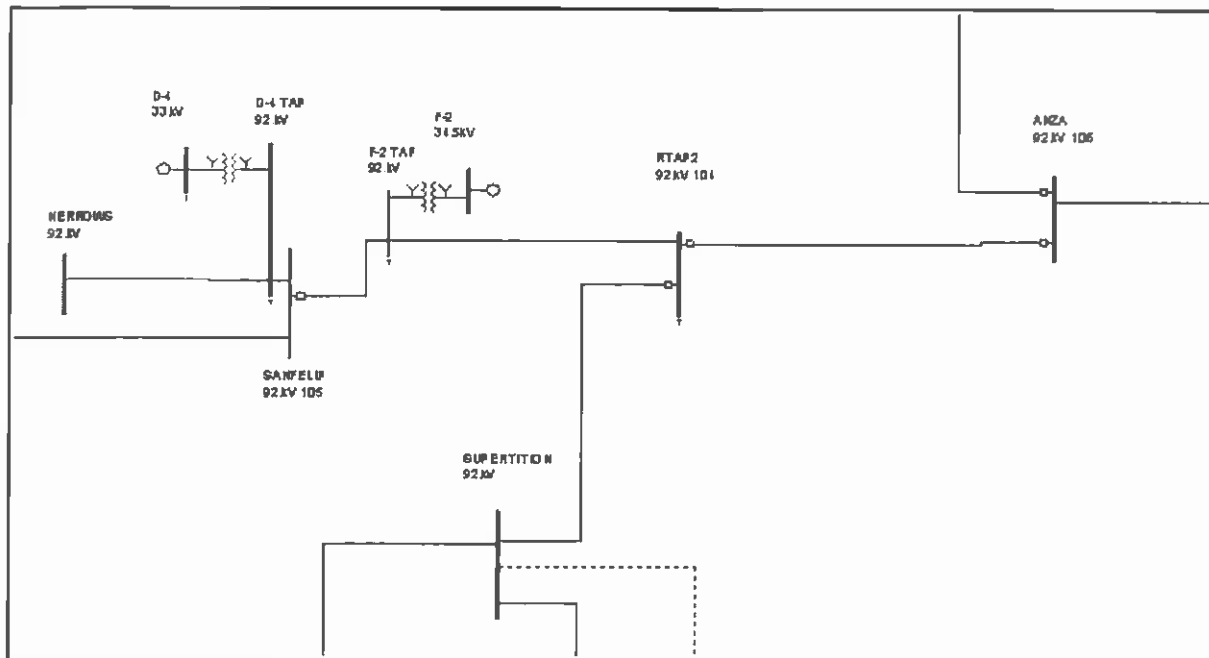


Figure 2: Gildred Solar #1 Project ASPEN Model

## STUDY RESULTS

This section provides the results obtained by applying the stated study assumptions and the general study methodology. It illustrates the findings associated with the power flow for both the pre- and post-project base cases.

### Power Flow Analysis Findings

This section details the findings of the power flow analysis. WECC/NERC reliability criteria were used to assess the adequacy of the study results.

#### *Heavy Summer Pre and Post Project Base Case*

In the Pre and Post-project analysis, the CSO project was dispatched and delivered as prescribed in project's interconnection application. The addition of the CSO project adversely impacted the thermal loadings under N-1 and N-2 conditions. The heavy summer post-project power flow map can be found at Appendix A, Figure A2-2.

Key findings from the power flow analysis using the heavy summer post-project base case are provided below. A comparison of the impact of CSO project on the IID and the interconnected transmission systems are also detailed. It must however be noted that for screening purposes IID typically uses identical continuous and emergency ratings for its facilities. Typically 110% of continuous rating of transformers and 92 kV lines is an acceptable emergency rating for 30 minutes.

## N-0 Findings

- No transmission facility overload was identified during normal operating conditions

## N-1 Findings

Heavy Summer Project Base Case - Per Unit Flow Violations (N-1)											
FROM	NAME	KV	TO	NAME	KV	MVA	Pte	F2 only	F2 & D4	CONTINGENCY DESCRIPTION	
8376	RTAP2	92	8030	F-2TAP	92	54.0	N/A	84.78%	130.28%	Base system (n-0)	
8319	DXIELAN	92	8974	RTP1	92	51.0	32.55%	61.74%	106.83%	Line AVE58 92.0 to OASIS 92.0 Circuit 1	
8332	ELCENTSW	230	22356	IMPRLVLY	230	370.0	94.79%	100.18%	103.10%	Line NGLA to IMPRLVLY 500 ck 1	
8319	DXIELAN	92	8974	RTP1	92	51.0	10.17%	85.01%	128.98%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1	
8376	RTAP2	92	8974	RTP1	92	57.0	8.54%	76.13%	115.52%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1	

## N-2 Findings

Heavy Summer Project Base Case - Per Unit Flow Violations (N-2)											
FROM	NAME	KV	TO	NAME	KV	MVA	Pre	F2 only	F2 & D4	CONTINGENCY DESCRIPTION	
8376	RTAP2	92	8030	F-2TAP	92	54.0	N/A	84.78%	130.28%	Base system (n-0)	
8376	RTAP2	92	8377	RTP3ANZA	92	91.0	63.62%	91.65%	106.81%	Line EL SWITCH 230.0 to M/SUB 230kV & EL SWITCH to AVE58(L) 161kV	
8319	DXIELAN	92	8974	RTP1	92	51.0	32.55%	61.73%	106.84%	Loss of Transmission from AVE58 TO RTP5OSTS(R)92kV & from Ave 58 to COACHELLA(R)	

## Light Winter Pre and Post-Project Base Case

In the Post-project analysis, the CSO project was dispatched and delivered as prescribed in project's interconnection application. Compared to the Pre-project base case, the addition of the CSO project did not show any considerable changes in voltage or thermal loadings under normal conditions. The light winter post-project power flow map can be found at Appendix A1, Figure A1-4.

## N-0 Findings

- No transmission facility overload was identified during normal operating conditions

## N-1 Findings

Light Winter Project Base Case - Per Unit Flow Violations (N-1)												
FROM	NAME	KV	TO	NAME	KV	AREA	ZONE	MVA	Pre	F2 only	F2 & D4	CONTINGENCY DESCRIPTION
8376	RTAP2	92	8030	F-2TAP	92	8	163	54.0	N/A	85.16%	127.86%	Base system (n-0)
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	7.27%	84.49%	126.96%	Line AVE58 92.0 to OASIS 92.0 Circuit 1
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	4.60%	87.51%	130.08%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1
8376	RTAP2	92	8974	RTP1	92	8	163	57.0	3.51%	78.35%	116.48%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1
8331	ELCENTSW	161	8335	ELSTEAMP	92	8	163	125.0	96.44%	111.95%	118.09%	Tran ELCENTSW 230.00 to ELSTEAMP 92.00 Circuit 1

## N-2 Findings

Light Winter Project Base Case - Per Unit Flow Violations (N-2)												
FROM	NAME	KV	TO	NAME	KV	AREA	ZONE	MVA	Pre	F2 only	F2 & D4	CONTINGENCY DESCRIPTION
8376	RTAP2	92	8030	F-2TAP	92	8	163	54.0	N/A	85.16%	127.86%	Base system (n-0)
8319	DXELAN	92	8974	RTP1	92	8	163	51.0	7.27%	84.51%	128.88%	Loss of Transmission from AVE58 TO RTP5OSTS(R)92kV & from Ave 58 to COACHELLA(R)
8376	RTAP2	92	8974	RTP1	92	8	163	57.0	5.98%	75.62%	113.68%	Loss of Transmission from AVE58 TO RTP5OSTS(R)92kV & from Ave 58 to COACHELLA(R)
8319	DXELAN	92	8974	RTP1	92	8	163	51.0	80.59%	131.71%	159.13%	W/RAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE
8332	ELCENTSW	230	22356	IMPRLVLY	230	8	163	370.0	99.48%	107.57%	112.15%	W/RAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE
8359	NLAND	181	19020	BLTYHE	161	8	163	105.0	94.90%	98.68%	101.08%	W/RAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE
8376	RTAP2	92	8974	RTP1	92	8	163	57.0	72.83%	116.24%	142.76%	W/RAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE



## Short Circuit Analysis Findings

With the addition of the GS1 Project and the equivalent unit modeled as described in the Assumptions section of the report, the post-project short circuit study results indicated that the expected fault duty at the point of interconnection to the F-2 TAP 92kV substation is approximately 2,569 A (three-phase) and 1,972.8 A (single-phase-to ground). The incremental fault duties due to the GS1 Project were found to be 7297.0A (three-phase) and 265.1A (single-phase-to-ground, and due to the delta-wye grounded step-up transformer). Table 6 provides a summary of the pre-project, post-project and incremental fault duties buses at the point of interconnection and nearby buses. Additional fault levels are contained in Appendix A4 of this report for other regional buses in the ASPEN model.

**Table 6: Summary of Short Circuit Analysis Results**

F-2 Plant (With D-4)		Post-Project Case Without D-4		Post-Project Case With D-4		Incremental	
		3LG	1LG	3LG	1LG	3LG	1LG
Substation Location	kV	Phase (A)	Ground (A)	Phase (A)	Ground (A)	Phase (A)	Ground (A)
F-2 TAP (POI)	92	2272	1707.7	2569	1972.8	297.0	265.1
SANFELIP	92	1989	1448.1	2324.8	1747	335.8	298.9
RTAP2	92	2856.6	2120.8	3013.1	2278.6	156.5	157.8
SUPERTITION	92	3846.1	3260.3	3924.4	3322.2	78.3	61.9
ANZA	92	2683.2	1841.4	2740.1	1880.2	56.9	38.8

## MITIGATION PLANS

Based on the study results, several elements on the IID electrical system will be impacted due to the addition of GS1 Project. The thermal loading violations on several IID transmission elements due to the critical contingencies reported in this study justify the implementation of two system operating procedure (SOP), Two Remedial Actions Scheme (RAS) and four System Upgrades in order to mitigate either temporarily (SOP's and RAS's) or permanent (System Upgrades) each violation found on this analysis. The implementation of the subject SOPs and RAS's will be contingent to the IID system conditions when the GS1 Project becomes in-service. Therefore, IID will evaluate the need to re-study this sensitivity study to confirm which SOPs or RAS's will be required to implement before the in-service date of this project.

GILDRED SOLAR #1 PROJECT - SENSITIVITY STUDY (50 MW)				
High Level Cost Estimate/Cost Allocation				
Assuming a 26 MW and a 50 MW Projects Connected to "R" 92 kV Line In-service				
Affected Element	High Overload (%)	Share Cost Allocation (Dollars)	Affected Element Upgrade Description	Most Critical Outage Affecting the Element
1.- "R" 92 kV Line (RTAP2-F-2TAP)		6,664,420	6.9 Miles of 2/0 BC Upgraded to 795 AAC Remove/Re-build 6.9 miles assuming \$965.858k/mile =50/76 MW, (it represents Gildred's share cost)	N-Q Condition
% of share cost=====		65.80%		
Share Cost Alloc. to Gen. Proj=		4,385,168		
2.- "R" 92 kV Line (DIXIELAN-RTP1)		5,601,976	5.8 Miles of 2/0 BC Upgraded to 795 AAC Remove/Re-build 5.8 miles assuming \$965.858k/mile =50/76 MW, (it represents Gildred's share cost)	RTP3-ANZA to Desert Shores 92 kV
% of share cost=====		65.80%		
Cost Alloc. to Gen. Proj=		3,686,100		
3.- "R" 92 kV Line (RTP1-RTAP2)		\$ 19,317,160	20 Miles of 2/0 BC & 397.5 AAC Upgraded to 795 AAC Remove/Re-build 20 miles assuming \$965.858k/mile =50/76 MW, (it represents Gildred's share cost)	RTP3-ANZA to Desert Shores 92 kV
% of share cost=====		65.80%		
Cost Alloc. to Gen. Proj=		12,710,691		
4.- El Centro Sw. Sta. 125 MVA 161/92 kV Bk #2		6,583,389	Reference is the Niland 250 MVA Transformer Cost Estimate Provided by the IID System Engineering group	El Centro S.S. 230/92 kV 332 MVA Bank #4
% of share cost=====		100.00%	(The cost allocation was 100% since the Bank #2 overloading was 111.95 %)	
Cost Alloc. To Gen. Proj=		6,583,389		
SOPs:				
			<b>"ELEMENT OVERLOADED"</b>	
#1 SOP to Mitigate Temporarily Overloading		200,000	"5" 230 kV Line (El Centro-Imperial Valley 230 kV)	
#2 SOP to Mitigate Temporarily Overloading		200,000	"R" 92 kV Line (RTAP2-RTP3ANZA)	
		400,000		
RAS:				
			<b>"ELEMENT OVERLOADED"</b>	
#1 RAS to Mitigate Permanently Overloading		350,000	"5" 230 kV Line (El Centro-Imperial Valley 230 kV)	
#2 RAS to Mitigate Permanently Overloading		350,000	"F" 161 kV Line (Niland-Blythe)	
		700,000		
TOTAL HLCE:=====		\$ 28,465,369		

The power flow results for both the heavy summer and light winter base cases can be found in Appendix A2. Power flow maps with all transmission lines in service can be found in Appendix A1. Transient stability analysis was performed and the system was found to be stable and adequately damped with no WECC/NERC criteria violations.

The Imperial Irrigation District (IID) is currently performing a Cluster Impact Study. The proposed project evaluated in this report is the GS1 project, which is one of the participants in the cluster study. IID was asked from Gildred Building Company to perform a sensitivity analysis on the GS1 project outside of the cluster study. On the radial line where the GS1 project is planning to interconnect there is also another planned generation interconnection project. Due to the radial characteristic of the line and the similar electrical points of the two generation projects, IID has decided to review the sensitivity analysis of the GS1 project with and without the added generation. The following results are without D-4 project electrically connected at San Felipe substation.

<u>GILDRED SOLAR #1 PROJECT - SENSITIVITY STUDY (50 MW)</u>				
High Level Cost Estimate/Cost Allocation				
Assuming a 50 MW Project Connected to "R" 92 kV Line In-service, only				
Affected Element	High Ovrl (%)	Share Cost Allocation (Dollars)	Affected Element Upgrade Description	Most Critical Outage Affecting the Element
<hr/>				
1. El Centro Sw. Sta. 125 MVA 161/92 kV Bk #2		6,583,389	Reference is the Niland 250 MVA Transformer Cost Estimate Provided by the IID System Engineering group	El Centro S.S. 230/92 kV 332 MVA Bank #4
<hr/>				
% of share cost=====		100.00%	(The cost allocation was 100% since the Bank #2 overloading was 111.95 %)	
Cost Alloc. To Gen. Proje=		6,583,389		
<hr/>				
SOPs:				
<u>"ELEMENT OVERLOADED"</u>				
#1 SOP to Mitigate Temporarily Overloading		200,000	"S" 230 kV Line (El Centro-Imperial Valley 230 kV)	
		200,000		
<hr/>				
RAS:				
<u>"ELEMENT OVERLOADED"</u>				
#1 RAS to Mitigate Permanently Overloading		350,000	"S" 230 kV Line (El Centro-Imperial Valley 230 kV)	
#2 RAS to Mitigate Permanently Overloading		350,000	"F" 161 kV Line (Niland-Blythe)	
#2 RAS to Mitigate Permanently Overloading		350,000	"R" 92 kV Line (Dixie-La-RTP1)	
		1,050,000		
<hr/>				
TOTAL HLCE:-----		\$ 7,633,389		

## **Appendix A1**

### **Power flow Maps: GS1 Study**

**Figure A1-1: Power Flow Map—Gilded Solar 1 Pre Project without D-4 (Heavy Summer)**

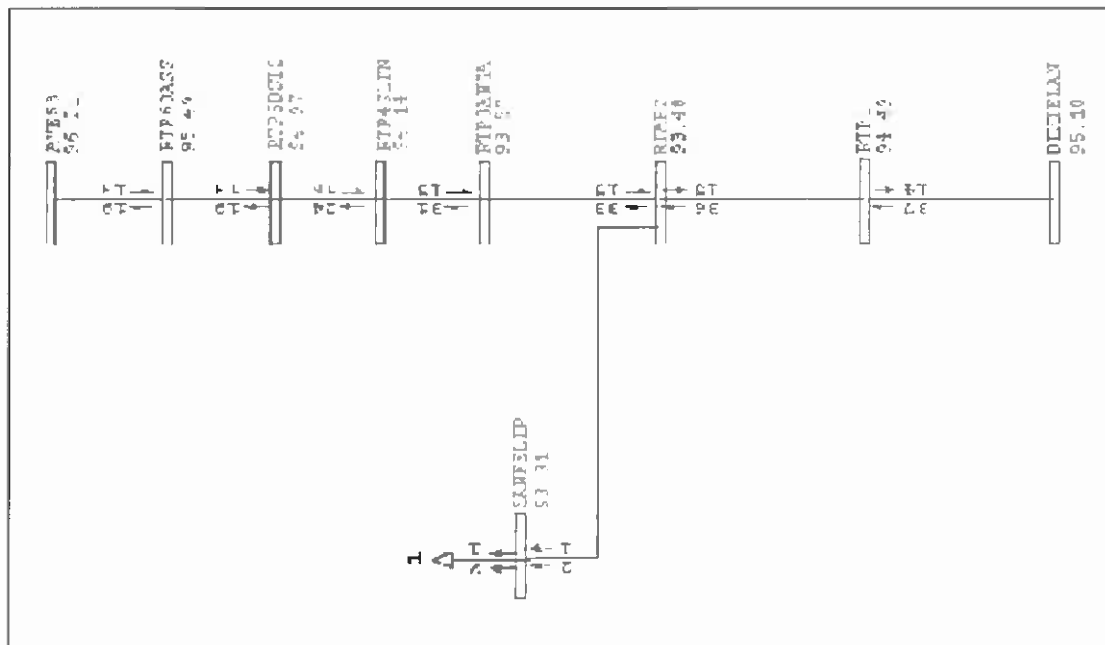


Figure A1-2: Power Flow Map—Gildred Solar 1 Post Project without D-4 (Heavy Summer)

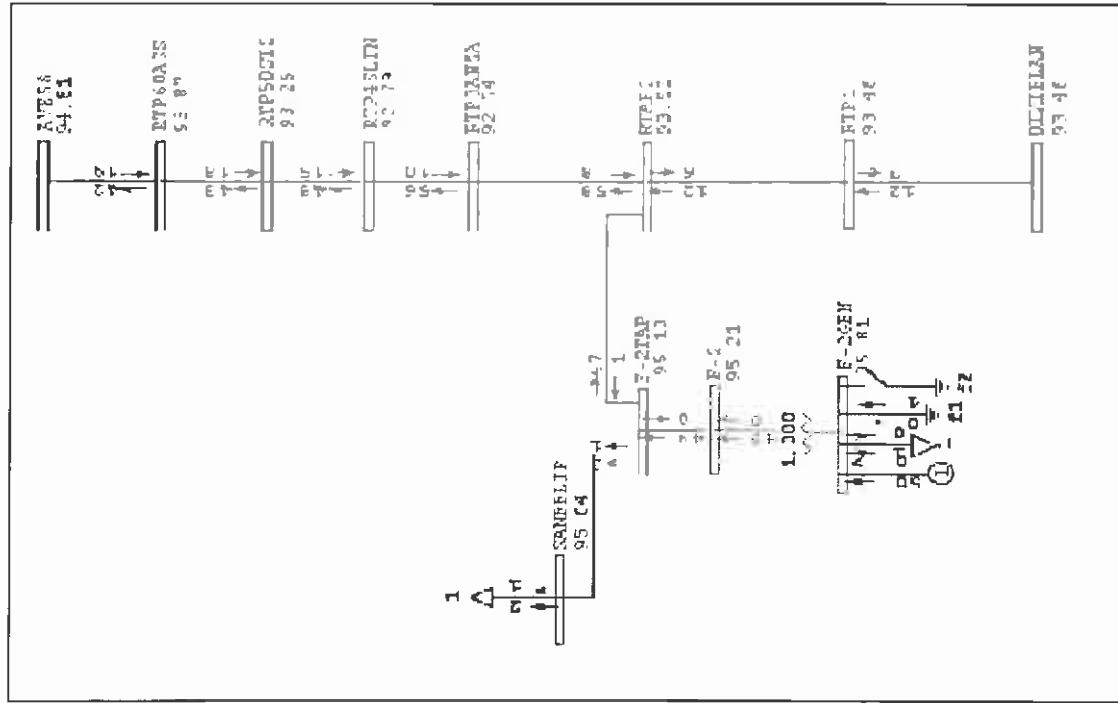
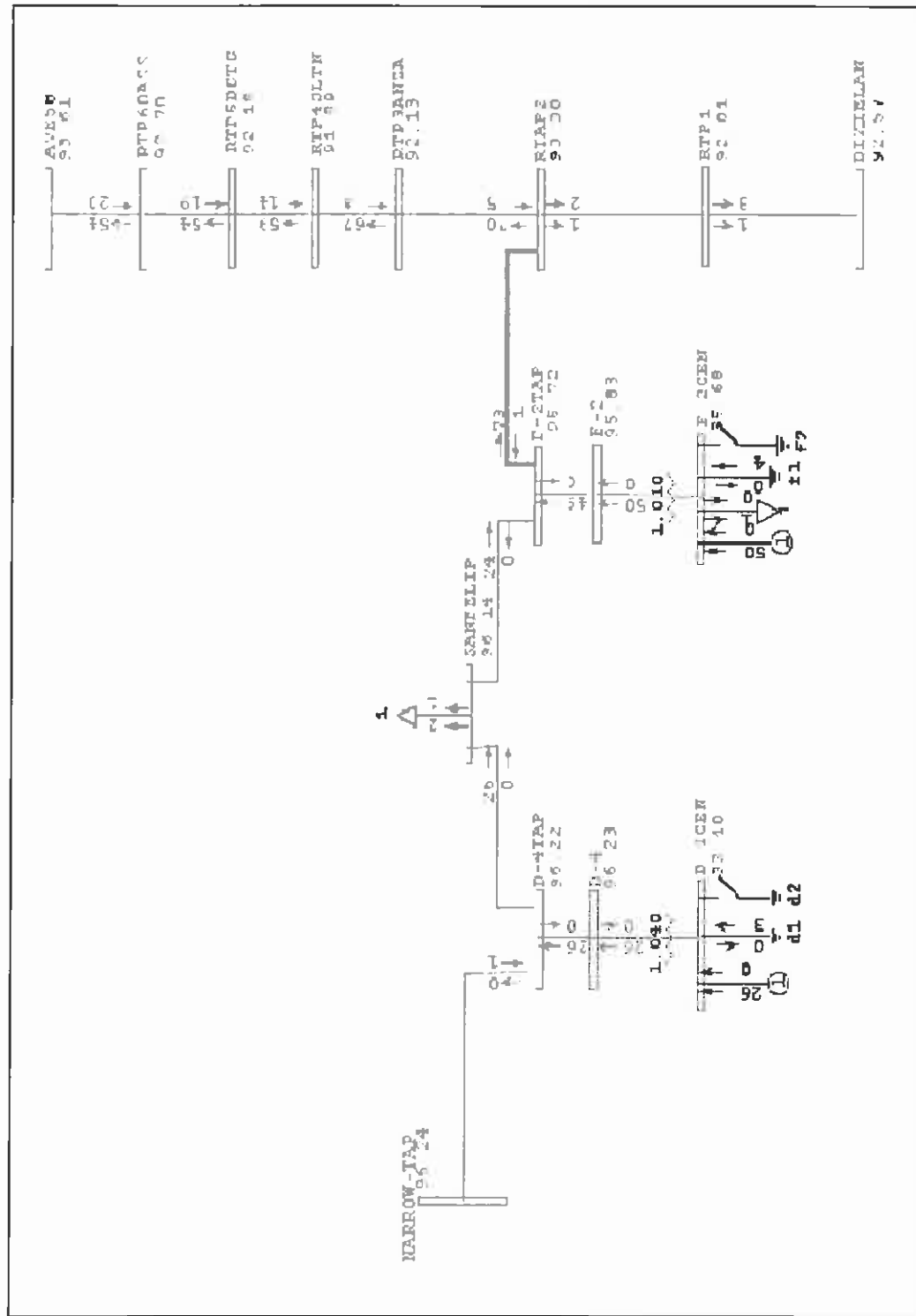


Figure A1-3: Power Flow Map— Gildred Solar 1 Post Project with D-4 (Heavy Summer)







**Figure A1-5: Power Flow Map—Gilded Solar 1 Post Project without D-4 (Light Winter)**

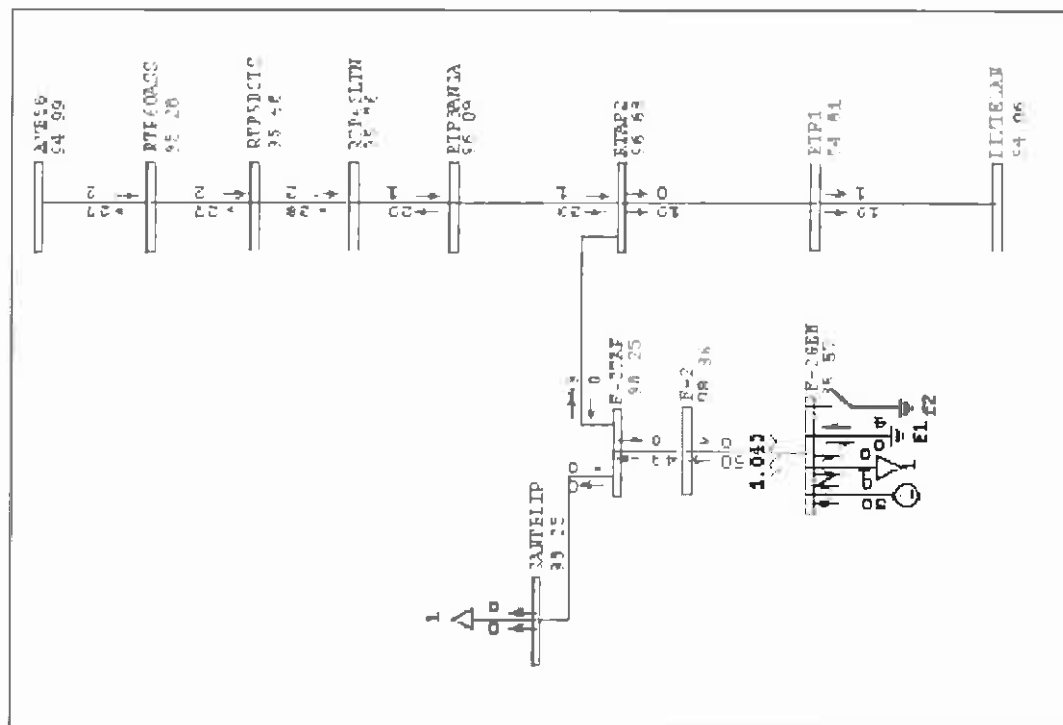
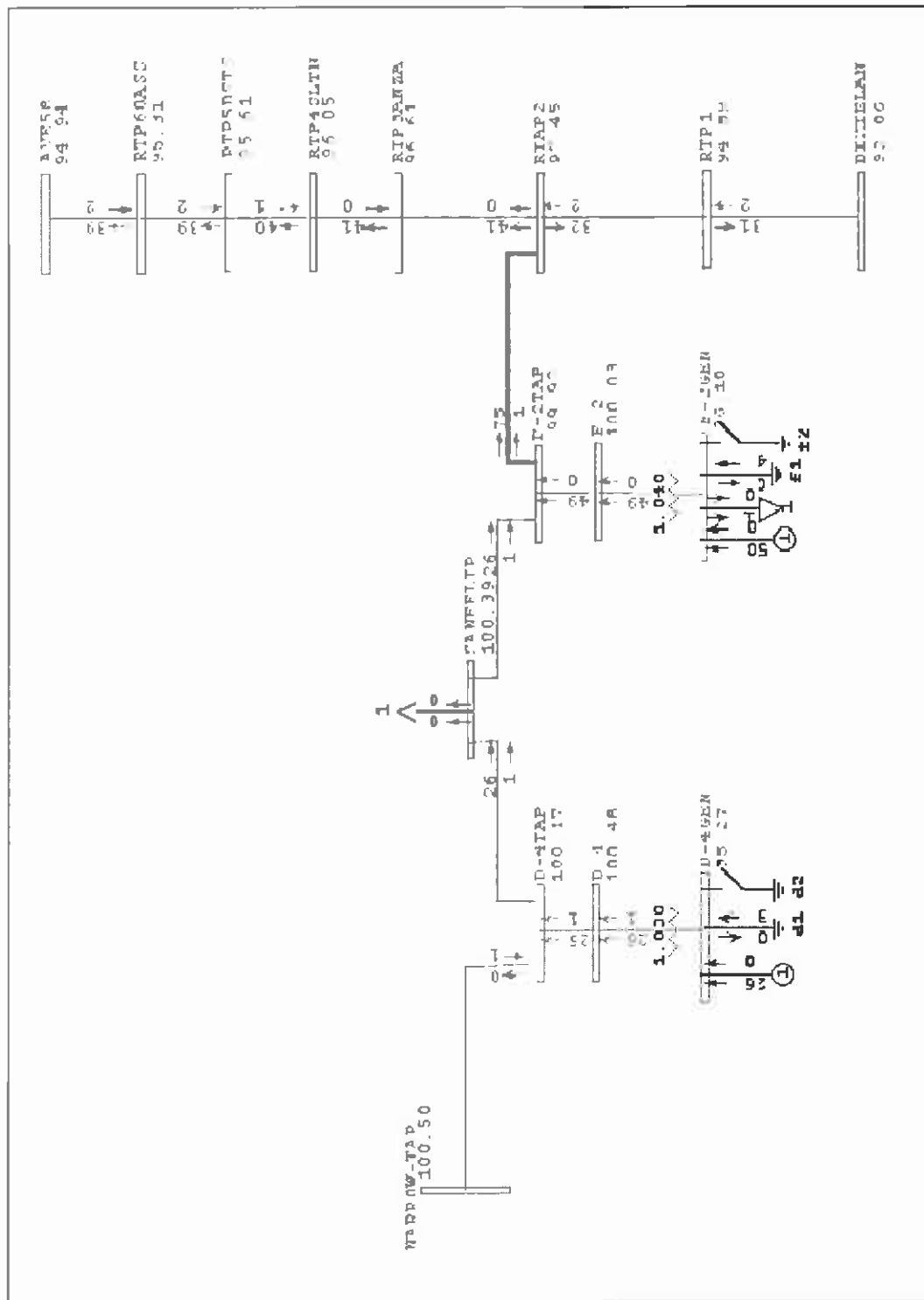


Figure A1-6: Power Flow Map—Gildred Solar 1 Post Project with D-4 (Light Winter)



## **Appendix A2**

### **Summary of Power Flow Analysis Results: GS1 Study**

Table A2-1: Summary of 2012 Heavy Summer Power Flow Analysis Results— N-1 Thermal Overloads

Heavy Summer Project Base Case - Per Unit Flow Violations (N-1)												
FROM	NAME	KV	TO	NAME	KV	AREA	ZONE	MVA	Pre	F2 only	F2 & D4	CONTINGENCY DESCRIPTION
8376	RTAP2	92	8030	F-2TAP	92	8	163	54.0	N/A	84.78%	130.28%	Base system (n-0)
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	32.55%	61.74%	106.83%	
8332	ELCENTSW	230	22356	MPRLVLY	230	8	163	370.0	94.79%	100.19%	103.10%	Line AVE58 92.0 to OASIS 92.0 Circuit 1
8359	NILAND	161	8361	NILAND	92	8	163	75.0	100.93%	102.04%	105.05%	line N.GILA to MPRLVLY 500 ck 1
8359	NILAND	161	8361	NILAND	92	8	163	75.0	117.75%	118.92%	121.92%	Line NEW MECCA to AVE 52 92.0 Circuit 1
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	101.80%	49.97%	23.72%	Line NILAND 92.0 to NEW MECCA 92.0 Circuit 1
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	10.17%	85.01%	128.98%	line PALOVROE to DEVERS 500 ck 1
8376	RTAP2	92	8974	RTP1	92	8	163	57.0	8.54%	76.13%	115.52%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1
8331	ELCENTSW	161	8335	ELSTEAMP	92	8	163	125.0	97.32%	110.52%	118.40%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1
												Tran ELCENTSW 230.00 to ELSTEAMP 92.00 Circuit 1

Table A2-4: Summary of 2012 Heavy Summer Power Flow Analysis Results— N-2 Thermal Overloads

Heavy Summer Project Base Case - Per Unit Flow Violations (N-2)												
										CONTINGENCY DESCRIPTION		
										Base system (n-0)		
FROM	NAME	KV	TO	NAME	KV	AREA	ZONE	MVA	Pre	F2 only	F2 & D4	
8376	RTAP2	92	8030	F-2TAP	92	8	163	54.0	N/A	84.78%	130.28%	
8376	RTAP2	92	8377	RTP3ANZA	92	8	163	91.0	63.62%	91.65%	106.81%	Line EL SWITCH 230.0 to M/SUB 230kV & EL SWITCH to AVE58(L) 161kV
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	32.55%	61.73%	106.84%	Loss of Transmission from AVE58 TO RTP5DSTS(R)92kV & from Ave 58 to COACHELLA(R)

Table A2-7: Summary of 2012 Light Winter Power Flow Analysis Results— N-1 Thermal Overloads

Light Winter Project Base Case - Per Unit Flow Violations (N-1)												
FROM	NAME	KV	TO	NAME	KV	AREA	ZONE	MVA	Pre	F2 only	F2 & D4	CONTINGENCY DESCRIPTION
8376	RTAP2	92	8030	F-2TAP	92	8	163	54.0	N/A	85.16%	127.86%	Base system (n-0)
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	7.27%	84.49%	126.96%	Line AVE58 92.0 to OASIS 92.0 Circuit 1
8311	COACHELA	230	8699	MIDWAY	230	8	164	518.0	105.54%	105.74%	105.77%	Line COACHELA 230.0 to MIDWAY 230.0 Circuit 1
8311	COACHELA	230	8695	RAMON	230	8	164	392.0	118.04%	120.84%	122.40%	Line COACHELA 230.0 to MIRAGE 230.0 Circuit 1
8695	RAMON	230	24806	MIRAGE	230	8	162	494.0	103.77%	107.49%	109.46%	Line COACHELA 230.0 to MIRAGE 230.0 Circuit 1
8311	COACHELA	230	24806	MIRAGE	230	8	164	392.0	118.15%	120.95%	122.52%	Line COACHELA 230.0 to RAMON230 230.0 Circuit 1
8311	COACHELA	230	24806	MIRAGE	230	8	164	392.0	125.49%	129.87%	132.19%	Line RAMON230 230.0 to MIRAGE 230.0 Circuit 1
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	4.60%	87.51%	130.08%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1
8376	RTAP2	92	8974	RTP1	92	8	163	57.0	3.51%	78.35%	116.48%	Line RTP3-ANZA 92.0 to Desert Shores 92.0 Circuit 1
8331	ELCENTSW	161	8335	ELSTEAMP	92	8	163	125.0	96.44%	111.95%	118.09%	Tran ELCENTSW 230.00 to ELSTEAMP 92.00 Circuit 1

Table A2-10: Summary of 2012 Light Winter Power Flow Analysis Results— N-2 Thermal Overloads

Light Winter Project Base Case - Per Unit Flow Violations (N-2)										CONTINGENCY DESCRIPTION	
FROM	NAME	KV	TO	NAME	KV	AREA	ZONE	MVA	Pre	F2 only	F2 & D4
8376	RTAP2	92	8030	F-2TAP	92	8	163	54.0	N/A	85.16%	127.88%
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	7.27%	84.51%	126.99%
8376	RTAP2	92	8974	RTP1	92	8	163	57.0	5.98%	75.62%	113.68%
8319	DXIELAN	92	8974	RTP1	92	8	163	51.0	80.59%	131.71%	159.13%
8332	ELCENTSW	230	22356	MPRLVLY	230	8	163	370.0	98.48%	107.57%	112.15%
8359	NILAND	161	19020	BLYTHE	161	8	163	165.0	94.90%	98.88%	101.08%
8376	RTAP2	92	8974	RTP1	92	8	163	57.0	72.83%	118.24%	142.76%
										Base system (0-0)	
										Loss of Transmission from AVE58 TO RTP5DSTS(R)92KV & from Ave 58 to COACHELLA (R)	
										Loss of Transmission from AVE58 TO RTP5DSTS(R)92KV & from Ave 58 to COACHELLA (R)	
										WIRAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE	
										WIRAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE	
										WIRAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE	
										WIRAS RAMON230 230.0 to MIRAGE & COACHELLA 230.0 to MIRAGE	

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## **Appendix A3**

### **Short Circuit Analysis Results: GS1 Study**

**Table A4-1: Summary of Short Circuit Results**

**F-2 Short Circuit Study (With D-4 Generator)**  
**Circuit Breaker Capability Summary**

Date: 7/9/2012

Bus Name	Bus + KV	IID Substation Name	KV	Breaker Rating (A)	Maximum Phase Current	% of Interrupting Rating	Maximum Ground Current	Maximum X/R ratio
ANZA	ANZA 92	ANZA	92	30000	2740.1	9%	1880.2	5
ATEN	ATEN 92	ATEN	92	40000	16187.7	40%	11530.8	7.8
AVE-52	AVE-52 92	AVE-52	92	40000	14508.1	36%	13071.1	9.4
AVE 42 N BUS	AVE 42 N BUS 92	AVE 42	92	40000	13965.8	35%	14454.7	8.8
AVE48	AVE48 92	AVE 48	92	40000	10487.2	26%	9115.5	8
AVE58-161KV	AVE58-161KV 161	AVE 58	161	40000	6862.9	17%	7237.9	9.5
AVE58-92	AVE58-92 92	AVE 58	92	40000	13428.2	34%	13726.2	9.1
BEEF PLANT	BEEF PLANT 92	BEEF PLANT	92	40000	8635.2	22%	6404.7	7.8
BOMBAY	BOMBAY 92	BOMBAY	92	7500	4958.6	66%	2879.2	6.8
BRAVO 92 KV.	BRAVO 92 KV 92	BRAVO	92	40000	12469	31%	9309.4	7.6
BRAWLEY	BRAWLEY 92	BRAWLEY	92	40000	13009.2	33%	12183.9	8.8
CALEXICO	CALEXICO 92	CALEXICO	92	40000	10614.6	27%	8343.8	8.2
				20000		54%		
CALIPAT92	CALIPAT92 92	CALIPATIA	92	40000	10881.4	27%	8214.3	8.4
CARREON	CARREON 92	CARREON	92	40000	10503.8	26%	9279.7	8.1
CENTRAL	CENTRAL 92	CENTRAL	92	40000	12574.8	31%	9710.6	8.2
CLARK	CLARK 92	CLARK	92	40000	15337	38%	12474.3	8
CLPT-PRISON	CLPT-PRISON 92	CALIPATRIA PRISON	92	40000	10581	26%	7957.7	8.3
				40000		47%		
COACHELLA	COACHELLA 92	COACHELLA SW STA	92	22000	18603.1	20%	19959.8	11.8
COLMAC92	COLMAC92 92	COLMAC	92	40000	8078.4	20%	7222.9	10.8
CV-161	CV-161 161	COACHELLA VALLEY	161	40000	6890.7	17%	7188	11.4
CV-230	CV-230 230	COACHELLA VALLEY	230	40000	12194.9	30%	9995.2	11.8
CV-92	CV-92 92	COACHELLA VALLEY	92	40000	20991.6	52%	23484.6	14.1
				64000		24%		
DAHLIA	DAHLIA 92	DAHLIA	92	40000	15304.6	38%	12447	8.3
DEL RANCH	DEL RANCH 92	(CALENERGY) HOCH PLANT DEL RANCH	92	31500	6356.8	20%	6825.3	14.2
DESERT SHORE	DESERT SHORE 92	DESERT SHORES	92	40000	3694.5	9%	2207.2	5.9
DIXIE-PRISON	DIXIE-PRISON 92	DIXIELAND PRISON	92	40000	7278.9	18%	5298.2	7.1
DIXIELAND	DIXIELAND 92	DIXIELAND	92	40000	7809.7	20%	6517.9	7.3
DROP4	DROP4 92	DROP4	92	40000	10944.1	27%	8859.6	6.9
EARTH-PLANT	EARTH-PLANT 92	(CALENERGY)SALTON SEA 2 - EARTH PLANT	92	20000	6065.6	30%	5913	13.4
EDOM	EDOM 92	EDOM	92	40000	10676.9	27%	10542.3	11.3
ELCENTSW	ELCENTSW 92	EL CENTRO SW STA	92	40000	35956.7	90%	43052.5	16.6
				18000		58%		
ELCENTSW	ELCENTSW 161	EL CENTRO SW STA	161	40000	10417.5	26%	10195	12.5
				63000		18%		
ELCENTSW	ELCENTSW 230	EL CENTRO SW STA	230	40000	11293.4	28%	9570.6	11.2
ELMORE-92 k	ELMORE-92k 92	(CALENERGY) ELMORE	92	31500	6929.3	22%	7696.2	15
				64000		26%		
EUCLID	EUCLID 92	EUCLID	92	40000	16586.5	41%	13320.9	8.4
FRANCES WAY-	FRANCES WAY- 92	FRANCES WAY	92	40000	9193.9	23%	7337.6	8
GATEWAY-92	GATEWAY-92 92	GATEWAY	92	40000	9713.1	24%	6555.6	6.5
GEM 2 &3	GEM 2 & 3 92	GEM 2 &3	92	N/A	8229.4		9679.7	23.2
HEBER	HEBER 92	HEBER	92	40000	13246.1	33%	11343.9	9.3
HEBER IMP	HEBER IMP 92	HEBER IMPERIAL	92	20000	13434.7	67%	11868.5	9.9
HEBER SOUTH	HEBER SOUTH 92	HEBER SOUTH	92	40000	13434.5	34%	11869.1	9.9
HEBERSCE	HEBERSCE 92	HGC PLANT (HEBER SCE)	92	20000	13225.6	66%	11896.6	9.7
HIGHLINE230	HIGHLINE230 230	HIGHLINE	230	40000	5292.2	13%	4264	13
HIGHLINE92	HIGHLINE92 92	HIGHLINE	92	40000	9563.2	24%	12914.5	29.5
HOLTVILLE	HOLTVILLE 92	HOLTVILLE	92	40000	12434	31%	9949.8	7.9

Cont...

Bus Name	Bus + KV	IID Substation Name	kV	Breaker Rating (A)	Maximum Phase Current	% of Interrupting Rating	Maximum Ground Current	Maximum X/R ratio
JACKSON	JACKSON 92	JACKSON	92	31500		31%		
				40000	9802.6	25%	8873.1	8.5
JEFFERSON92	JEFFERSON92 92	JEFFERSON	92	40000	8629.8	22%	7878.8	7.9
LAQUINTA92	LAQUINTA92 92	LA QUINTA	92	40000	8821.6	22%	8356.4	8
LEATHE-PLANT	LEATHE-PLANT 92	(CALENERGY) LEATHERS PLANT	92	31500	6805.2	22%	6784.2	13.5
MALL	MALL 92	MALL	92	40000	13557.4	34%	10256.6	8.2
MIDWAY230	MIDWAY230 230	MIDWAY	230	40000	8086.3	20%	6688.5	15.4
MIDWAY92	MIDWAY92 92	MIDWAY	92	40000	15027.4	38%	17369.8	22.1
MONROE	MONROE 92	MONROE	92	40000	11447.1	28%	10438.7	8.2
N LA QUINTA	N LA QUINTA 92	NORTH LA QUINTA	92	40000	9577.2	24%	9025.6	8
NAVY BASE	NAVY BASE 92	NAVY BASE	92	40000	10111.3	25%	6807.9	7
NEW IMPERIAL	NEW IMPERIAL 92	NEW IMPERIAL	92	40000	12859.3	32%	9443.4	7.4
NEW MECCA	NEW MECCA 92	NEW MECCA	92	40000	5727.2	14%	4084.6	7.8
NILAND	NILAND 92	NILAND	92	40000	14201.5	36%	16276	13
				40000		18%		
				18000		41%		
NILAND	NILAND 161	NILAND	161	31000	7320.4	24%	6363.6	6.7
NORTHVIEW	NORTHVIEW 92	NORTHVIEW	92	40000	10230.6	26%	8916.2	8.4
ORMESA 1	ORMESA 1 92	ORMESA #1	92	N/A	6575.4		7057.5	17.3
ORMESA 2	ORMESA 2 92	ORMESA #2	92	N/A	7234.7		7915.5	19.9
PANNO	PANNO 92	PANNO	92	40000	10878.5	27%	7217.1	7.5
				40000		24%		
PARKVIEW	PARKVIEW 92	PARKVIEW	92	20000	9534.8	48%	7751.3	8.2
				40000		35%		
PERRY	PERRY 92	PERRY	92	26000	13830.8	53%	11694.9	8.8
PILOTKNOB	PILOTKNOB 92	PILOTKNOB	92	40000	7918.3	20%	7673.9	14.7
				40000		33%		
PILOTKNOB	PILOTKNOB 161	PILOTKNOB	161	16000	13112	35%	12214.8	8.7
PLASTER-CITY	PLASTER-CITY 92	PLASTER CITY	92	40000	5580.8	14%	4363.5	6.9
PRUETT	PRUETT 92	PRUETT	92	40000	13230.1	33%	10563.8	8.4
RAMON	RAMON 92	RAMON	92	40000	12761.5	32%	14154.8	13.7
RAMON	RAMON 230	RAMON	230	40000	12830.6	32%	12389.2	9.7
ROCKWOOD	ROCKWOOD 92	ROCKWOOD	92	20000	13099.7	65%	12788.9	9
SANFELIP	SANFELIP 92	SANFELIPE	92	10000	2324.8	23%	1747	5.7
SHADOW HILLS	SHADOW HILLS 92	SHADOW HILLS	92	40000	11681.7	29%	10842.8	7.6
SHIELDS	SHIELDS 92	SHIELDS	92	64000	12131.5	19%	11667.3	8.4
				10000		15%		
SKYVALLEY	SKYVALLEY 92	SKY VALLEY	92	16000	1488.7	9%	1149	1.2
TERMINAL 92	TERMINAL92 92	TERMINAL	92	40000	25389.2	63%	25044.5	11.4
TRX WESTBIO1	TRX WESTBIO1 92	WESTERN 1	92	N/A	10072.5		9607.9	7.3
TRX-WESTBIO2	TRX-WESTBIO2 92	WESTERN 2	92	N/A	10060.5		9593.6	7.2
UNIT NO 4	UNIT NO 4 92	(CALENERGY) SALTON SEA4 - UNIT 4	92	20000	6231.4	31%	6162	13.8
UNIT NO 5	UNIT NO 5 92	(CALENERGY) SALTON SEA - UNITS 3 & 5	92	20000	5759.3	29%	5805	13.3
VANBUREN	VANBUREN 92	VANBUREN	92	40000	12117.7	30%	11722	7.2
VULCAN 1	VULCAN1 92	(CALENERGY) VULCAN1	92		7047		7075.5	13.6



Cont...

Bus Name	Bus + KV	IID Substation Name	kV	Breaker Rating (A)	Maximum Phase Current	% of Interrupting Rating	Maximum Ground Current	Maximum X/R ratio
34.5 SYSTEM								
BRAVO	BRAVO 34.5	BRAVO	34.5	31500		22%		
BRAWLEY DIES	BRAWLEY DIES 34.5	BRAWLEY DIESEL	34.5	40000	6785.6	17%	7074.6	18.6
CALIPAT	CALIPAT 34.5	CALIPATRIA	34.5	19000	7791.3	41%	6535.9	3.6
DIXIELAND	DIXIELAND 34.5	DIXIELAND	34.5		4924.9		5151.2	34.9
DROP 1	DROP 1 34.5	DROP 1	34.5		2713.2		1924.1	92.4
DROPO # 3	DROPO#3 34.5	DROP 3	34.5	25100	5195.9	21%	4901.2	7.1
DROPSAP	DROPSAP 34.5	DROP 5	34.5		4569.1		3914.5	5.5
DROPSAP	DROPSAP 34.5	DROP 5	34.5	10000	4738.4	47%	4034.8	8
E HILNTP	E HILNTP 34.5	EAST HIGHLINE	34.5		3648.4		2876.4	4.5
HOLTVILLE	HOLTVILLE 34.5	HOLTVILLE	34.5		6233.5		4758.3	6.5
PILOTKNOB	PILOTKNOB 34.5	PILOTKNOB	34.5	8367	7266.8	87%	6973.9	16.7
WINTERHAVEN	WINTERHAVEN 34.5	WINTERHAVEN	34.5	8367	3402.6	41%	2290.3	2.5



Fault above 80% of breaker interrupting capability  
 Fault above 90% of breaker interrupting capability  
 Fault above 100% of breaker interrupting capability